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On the Neutrality of Socially Responsible Investing*

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Abstract

This paper analyzes socially responsible investment in the Walrasian model with uncertainty. It proves the following neutrality result: if each consumer's utility function with social responsibility is a function of her utility without social responsibility and asset holdings and if financial assets guarantee market completeness independently of stock payoffs, then socially responsible investment changes nothing but investors' financial portfolios and their subjective utilities, leaving resource allocation, goods prices, and asset prices completely unaffected. That is, with complete financial markets SRI is neutral unless it also has an impact on agents' consumption choices. The one-good representative agent version of the model is used to show that with incomplete markets, by contrast, neutrality of socially responsible is the exception rather than the rule.

JEL classification: D51, G14, M14

Key words: socially responsible investing, Modigliani-Miller theorem, general equilibrium

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1 Introduction

Socially responsible investment (SRI) has become an important factor in asset allocation. According to the Global Sustainable Investment Alliance, the volume of SRI assets was \$22.89 trillion at the beginning of 2016.¹ This paper analyzes SRI in the Walrasian general equilibrium model with time and uncertainty. It proves the following neutrality result: if each consumer's utility function with social responsibility is a (separable) function of her utility without social responsibility and her asset holdings motivated by the pursuit of SRI-related goals and if there are financial assets which guarantee market completeness independently of stock payoffs, then the presence of SRI changes nothing but investors' financial portfolios and their subjective utilities, leaving resource allocation, goods prices, and asset prices completely unaffected. This result is a folk theorem in the SRI literature. It is mentioned in verbal accounts of the effects of SRI (e.g., Davidson et al., 1995, p. 171, Angel and Rivoli, 1997, p. 58). And theoretical studies of SRI (reviewed below) regularly emphasize deviations from the Walrasian model as sources of real effects. Yet, despite its benchmark role, the conditions for and the scope of the result within the Walrasian general equilibrium model with uncertainty have not yet been investigated. We also analyze a representative agent version of the Walrasian model with incomplete financial markets. We find that with market incompleteness non-neutrality of SRI is the exception rather than the rule.

The neutrality result for the case of complete financial markets is trivial without uncertainty, i.e., when stocks and corporate bonds are safe assets. Suppose there is an equilibrium at which a subset of the consumers boycott the assets issued by a subset of the firms because they do not conform to certain acceptability criteria. While acceptable stocks and bonds are overrepresented in their portfolios, the purely financially motivated consumers' portfolios are skewed towards the other assets. The same portfolio choices, resource allocation, goods prices, and asset prices also constitute an equilibrium in the absence of SRI. To see this, suppose consumers give up the acceptability criteria. Since all stocks and bonds are safe assets, they are perfect substitutes then. There is no reason why some consumers' portfolios should be tilted towards assets issued by firms that obey screening criteria that are no longer in use. However, given perfect substitutability, there is no incentive to change one's portfolio either.

Given separability of utility between utility drawn from consumption and SRI-motivated

¹Global Sustainable Investment Alliance, "2016 Global Sustainable Investment Review", http://www.gsi-alliance.org/wp-content/uploads/2017/03/GSIR_Review2016.F.pdf.

asset holdings and given financial market completeness, this result generalizes to general equilibrium with uncertainty. (We also prove our main result with an alternative condition instead of separability.) The clue to the result is the observation that if there are financial assets which guarantee completeness of the financial market independently of stock payoffs and asset prices are arbitrage-free, then there is a multitude of portfolios which finance a given consumption vector. In particular, there is no incentive to hold a different portfolio in the absence of SRI than at an equilibrium with SRI.

An apparently simple supply-and-demand argument for the non-neutrality of SRI goes as follows: socially irresponsible firms' outputs would be higher and the damages they cause larger without SRI, because the demand for funds they issue and, hence, their capital stocks would be higher (see, e.g. Angel and Rivoli, 1997, p. 59). Our general equilibrium analysis shows that such supply-and-demand analysis is not generally applicable with complete markets and arbitrage-free prices: as asset demands are indeterminate (i.e., correspondences), there are no asset demand functions in the first place.

The fact that separability of overall utility between utility drawn from consumption and SRI-motivated asset holdings is a necessary precondition means that SRI is not neutral in general. What our neutrality result says is that with complete financial markets SRI is neutral unless it also has an impact on agents' consumption choices. This is a rather obvious caveat: if agents shift purchasing power from consumption goods considered unacceptable to others which conform to certain environmental, social, and governance standards, then more resources will move to the production of the latter goods, irrespective of agents' portfolio decisions (cf. Davidson et al., 1995, pp. 187–8, Angel and Rivoli, 1997, p. 58).

With incomplete financial markets there is one special case in which SRI is neutral, viz., if all firms are identical and, in particular, productivity shocks are perfectly positively correlated across firms. This is a second generalization of the neutrality result for the case of no uncertainty sketched above: since stocks of different firms are perfect substitutes in this case, there is no reason why consumers should hold a different portfolio in the absence than in the presence of SRI. Generally, neutrality of SRI is the exception rather than the rule in the Walrasian model with incomplete financial markets.

The paper is related to four strands of literature. First, it is related to existing models with real effects of SRI such as Heinkel et al. (2001), Beltratti (2005), Mackey et al. (2007), Gollier and Pouget (2014), and Dam and Scholtens (2015). Our analysis shows that incompleteness of the financial market is an important condition underlying existing neutrality results. We employ the incomplete markets version of our model in order to

reproduce existing non-neutrality results, thereby carving out the necessary conditions for real effects of SRI. Second, there is a large empirical literature on SRI (too large to be reviewed here), which analyzes the relative performance of SRI compared to neutral investment strategies and the efficacy of SRI in promoting pro-social firm behavior. Our neutrality result is consistent with studies which do not find significant abnormal returns (e.g., Galema et al., 2008) or a significant impact on firm behavior (e.g., Wagemans et al., 2013). Third, formally our analysis is closely related to Dubey and Shubik's (1985) and Dufwenberg et al.'s (2011) investigation of other-regarding preferences in general equilibrium. Dubey and Shubik (1985, p. 3) and Dufwenberg et al. (2011, Theorem 2, p. 618) show that, given a separability condition analogous to ours, a Walrasian equilibrium of an economy (without financial markets) in which consumers care for other consumers' well-being (or, in the case of Dufwenberg et al., 2011, consumption opportunities) is also an equilibrium of the "internal economy", in which interpersonal considerations do not play a role. The similarity of our result to theirs is obvious. Fourth, our neutrality theorem can be interpreted as a Stiglitz- (1969) type Modigliani-Miller theorem, which states that financial decisions are irrelevant with regard to resource allocation in general equilibrium. The paper is organized as follows. Section 2 introduces the model. Section 3 explains which markets are open and defines equilibrium. Section 4 states and proves our main result. Section 5 considers the one-good representative agent version of the model and the corresponding model with incomplete markets. This model is used in Section 6 to generate non-neutrality results and relate our model to the existing literature on non-neutrality of SRI. Section 7 concludes.

2 Model

There are two dates, 0 and 1. At date 1, there are a finite number of states of nature, labeled $s = 1, 2, \dots, S$.² At date 0, there is a single good. At date 1 there are L different goods, labeled $l = 1, 2, \dots, L$.

There are J_l single-output firms producing good l labeled j . They transform capital input k_{jl} at date 0 into output y_{jls} at date 1 according to the production function $f_{jls}(k_{jl})$. Returns are strictly decreasing, so that firms make positive profit. The state dependency of the production function allows for any kind of productivity shocks, the only source of risk in the economy. The vector of firm capital stocks is denoted $\mathbf{k} = (k_{11}, \dots, k_{j1}, \dots, k_{J_L L})$.

²The arguments generalize in the obvious way to a general probability space.

The economy is populated by I consumers labeled $i = 1, 2, \dots, I$. Consumer i 's consumption vector is $\mathbf{c}_i = (c_{i0}, c_{i11}, \dots, c_{iLS})$, where c_{i0} is consumption at date 0 and c_{ils} is consumption of good l in state s at date 1. i is endowed with y_{i0} units of the single available good at date 0 (and nothing at date 1). These endowments can be used for consumption or, when supplied to the firms, as capital.

Denote consumer i 's ownership share in producer j of good l as θ_{ijl} and her holdings of bonds issued by the firm as a_{ijl} . SRI is modeled by assuming that her asset holdings $\boldsymbol{\theta}_i = (\theta_{i11}, \dots, \theta_{iJLL})$ and $\mathbf{a}_i = (a_{i11}, \dots, a_{iJLL})$ affect i 's utility. In the absence of SRI, utility does not depend on $\boldsymbol{\theta}_i$ or \mathbf{a}_i . We assume that i 's utility in the SRI scenario $U_i(u_i(\mathbf{c}_i, \mathbf{k}), \boldsymbol{\theta}_i, \mathbf{a}_i, \mathbf{k})$ is a separable function of utility function without SRI $u_i(\mathbf{c}_i, \mathbf{k})$ (her “consumption utility” function) and her investment decisions. That is, the ranking of any set of consumption vectors \mathbf{c}_i is independent of i 's asset holdings. The analogous separability condition is used by Dubey and Shubik (1985, p. 3) and Dufwenberg et al. (2011, Section 2) in their analysis of other-regarding preferences. U_i is strictly increasing in its first argument, and u_i is strictly increasing in each consumption level (strong monotonicity). The presence of \mathbf{k} in u_i captures the (environmental and other) “physical” externalities emanating from goods production, which prevail independently of consumers' investment behavior. The dependence of U_i on \mathbf{k} allows for all sorts of interactions between i 's holdings of assets issued by firm j (i.e., θ_{ijl} and a_{ijl}) and j 's output $f_{jls}(k_{jl})$. Several examples will be encountered below.

The economy is denoted \mathcal{E} . The special case without SRI considerations (i.e., with $U_i(u_i(\mathbf{c}_i, \mathbf{k}), \boldsymbol{\theta}_i, \mathbf{a}_i, \mathbf{k}) = u_i(\mathbf{c}_i, \mathbf{k})$) is a standard Walrasian model with uncertainty and is denoted \mathcal{E}_0 .

3 Markets and equilibrium

Goods are traded in competitive spot markets. p_0 and p_{ls} denote the price at date 0 and the price of good l in state s at date 1, respectively. The price vector is $\mathbf{p} = (p_0, p_{11}, \dots, p_{ls}, \dots, p_{LS})$.

There are three types of financial markets. First, there is a market for safe corporate bonds. Firms sell bonds which pay off one unit of income in each state s at date 1 at price R , where $1/R$ is the safe interest rate. The number of bonds issued by l -producer j is exogenous and denoted b_{jl} . To make sure that j 's debt is in fact a safe asset, it is assumed

that $b_{jl} \leq \min_s p_{ls} y_{jls}$.³ Second, there is a competitive stock market, in which shares in all firms are traded. v_{jl} denotes the market capitalization of firm j producing good l , i.e., the total value at which its shares are traded in the stock market, and $\mathbf{v} = (v_{11}, \dots, v_{J_L L})$. θ_{ijl} entitles i to a fraction θ_{ijl} of l -producer j 's date-1 revenue net of debt service $p_{ls} y_{jls} - b_{jl}$. Consumer i 's initial ownership shares are denoted $\bar{\theta}_{ijl}$, and $\bar{\boldsymbol{\theta}}_i = (\bar{\theta}_{i11}, \dots, \bar{\theta}_{iJ_L L})$. We assume that i has to contribute $\bar{\theta}_{ijl} p_0 k_{jl}$ to firm j 's date-0 capital expenditure $p_0 k_{jl}$.⁴ Third, to make sure that the financial market is complete independently of the profile of stock payoffs, we assume that there is a state-contingent claim for each state s , which pays off one unit of income in state s and nothing otherwise. Its price is denoted r_s , and the vector of state-contingent claims prices is denoted $\mathbf{r} = (r_1, \dots, r_S)$.⁵ There are no short sale constraints.

Let z_{is} denote i 's purchases of state-contingent claim s and $\mathbf{z}_i = (z_{i1}, \dots, z_{iS})$. Consumer i 's budget constraints are:

$$p_0(c_{i0} - y_{i0}) + \sum_{l=1}^L \sum_{j=1}^{J_l} [\bar{\theta}_{ijl} (p_0 k_{jl} - R b_{jl}) + (\theta_{ijl} - \bar{\theta}_{ijl}) v_{jl} + R a_{ijl}] + \sum_{s=1}^S r_s z_{is} \leq 0 \quad (1)$$

$$\sum_{l=1}^L p_{ls} c_{ils} - \sum_{l=1}^L \sum_{j=1}^{J_l} [\theta_{ijl} (p_{ls} y_{jls} - b_{jl}) + a_{ijl}] - z_{is} \leq 0, \quad s = 1, \dots, S, \quad (2)$$

$i = 1, \dots, I$. The first constraint says that the sum of expenditure on consumption over and above the endowment, contributions to firm capital formation according to initial ownership shares, and the costs of the equity, bond, and state-contingent claims portfolios is non-positive. The latter constraints say that in each state the payoffs on stocks, bonds, and state-contingent claims are sufficient in order to finance consumption expenditure. Firms' objective as of date 0 is to maximize $v_{jl} - (p_0 k_{jl} - R b_{jl})$, the difference between its stock market valuation and the initial shareholders' contribution to investment expenditure. That is, firms act in the initial shareholders' financial interest. This is not self-evident, as a subset of SRI-motivated initial shareholders might prefer a different objective. We discuss the significance of this assumption in detail in Section 6.

³The Modigliani-Miller theorem is valid in the absence of bankruptcy: the b_{jl} 's do not affect equilibrium resource allocation and prices. On bankruptcy see Hellwig (1981).

⁴The analysis goes through without modification if consumers contribute to firm capital according to their post-trade ownership shares θ_{ijl} (see the remarks to the theorem in the next section).

⁵Any other set of financial assets that spans the state space leads to the same conclusions (see Section 4).

Definition: A consumption vector, stock holdings, bond holdings, and a state-contingent claims portfolio for each consumer, denoted $(\mathbf{c}_i, \boldsymbol{\theta}_i, \mathbf{a}_i, \mathbf{z}_i)_{i=1}^I$, capital stocks \mathbf{k} , goods prices \mathbf{p} , firm values \mathbf{v} , a bond price R , and state-contingent claims prices \mathbf{r} (in this order) are an equilibrium of \mathcal{E} if

$(\mathbf{c}_i, \boldsymbol{\theta}_i, \mathbf{a}_i, \mathbf{z}_i)$ maximizes U_i subject to the budget constraints (1) and (2), $i = 1, \dots, I$, k_{jl} maximizes $v_{jl} - (p_0 k_{jl} - R b_{jl})$, given $y_{jls} = f_{jls}(k_{jl})$, $j = 1, \dots, J_l$, $l = 1, \dots, L$, the goods markets clear, i.e.,

$$\sum_{i=1}^I c_{i0} + \sum_{l=1}^L \sum_{j=1}^{J_l} k_{jl} = \sum_{i=1}^I y_{i0}$$

$$\sum_{i=1}^I c_{ils} = \sum_{j=1}^{J_l} y_{jls}, \quad l = 1, \dots, L, \quad s = 1, \dots, S,$$

and the asset markets clear, i.e.,

$$\sum_{i=1}^I \theta_{ijl} = 1, \quad \sum_{i=1}^I a_{ijl} = b_{jl}, \quad j = 1, \dots, J_l, \quad l = 1, \dots, L,$$

$$\sum_{i=1}^I z_{is} = 0, \quad s = 1, \dots, S.$$

4 Neutrality of SRI

SRI is neutral in the sense that an allocation of resources, asset holdings, and prices that are an equilibrium of the economy with SRI are also an equilibrium without SRI. Formally:

Theorem 1: If $(\mathbf{c}_i^*, \boldsymbol{\theta}_i^*, \mathbf{a}_i^*, \mathbf{z}_i^*)_{i=1}^I$, \mathbf{k}^* , \mathbf{p}^* , \mathbf{v}^* , R^* , and \mathbf{r}^* are an equilibrium of \mathcal{E} , then they are an equilibrium of \mathcal{E}_0 .

Proof: Stocks and bonds are priced according to

$$v_{jl}^* = \sum_{s=1}^S r_s^* (p_{ls}^* y_{jls}^* - b_{jl}), \quad j = 1, \dots, J_l, l = 1, \dots, L, \quad (3)$$

where $y_{jls}^* = f_{jls}(k_{jl}^*)$, and

$$R^* = \sum_{s=1}^S r_s^*, \quad (4)$$

respectively, in \mathcal{E} . Otherwise there would be an arbitrage opportunity, which is inconsistent with utility maximization.

Arbitrage-free pricing has the following crucial implication. Suppose for given changes in the demands for stocks and bonds, $\Delta\theta_{ijl}$ and Δa_{ijl} , consumer i adjusts the demands for state-contingent claims such that c_{ils} is unchanged for all s , i.e.,

$$\Delta z_{is} = - \sum_{l=1}^L \sum_{j=1}^J [\Delta\theta_{ijl}(p_{ls}y_{jls} - b_{jl}) + \Delta a_{ijl}], \quad s = 1, \dots, S \quad (5)$$

(from (2)). Then (from (1)), as the total cost of i 's portfolio does not change, her date-0 consumption c_{i0} does not change either. That is, if a consumer can afford a consumption vector \mathbf{c}_i , then \mathbf{c}_i can be achieved with arbitrary stock and bond holdings by choosing an appropriate portfolio of state-contingent claims.

Suppose all prices (i.e., \mathbf{p}^* , \mathbf{v}^* , R^* , and \mathbf{r}^*) take on the same values in \mathcal{E}_0 as in \mathcal{E} . Then firms' objective functions $\sum_{s=1}^S r_s^*[p_{ls}^*f_{jls}(k_{jl}) - b_{jl}] - (p_0^*k_{jl} - R^*b_{jl})$ are the same in \mathcal{E}_0 as in \mathcal{E} . It follows that firms choose k_{jl}^* in \mathcal{E}_0 . It follows further that consumers' budget constraints are the same in \mathcal{E}_0 as in \mathcal{E} .

Suppose there are \mathbf{c}_i , $\boldsymbol{\theta}_i$, \mathbf{a}_i , and \mathbf{z}_i satisfying the budget constraints (1) and (2) such that $u_i(\mathbf{c}_i, \mathbf{k}^*) > u_i(\mathbf{c}_i^*, \mathbf{k}^*)$ for some i in \mathcal{E}_0 . Let $\Delta\theta_{ijl} = \theta_{ijl}^* - \theta_{ijl}$ and $\Delta a_{ijl} = a_{ijl}^* - a_{ijl}$. The consumption vector \mathbf{c}_i can also be obtained with stock holdings $\boldsymbol{\theta}_i^*$ and bond holdings \mathbf{a}_i^* and contingent claims demands $z_{is} + \Delta z_{is}$ with Δz_{is} given by (5). Since U_i is strictly increasing in its first argument, the ensuing utility satisfies $U_i(u_i(\mathbf{c}_i, \mathbf{k}^*), \boldsymbol{\theta}_i^*, \mathbf{a}_i^*, \mathbf{k}^*) > U_i(u_i(\mathbf{c}_i^*, \mathbf{k}^*), \boldsymbol{\theta}_i^*, \mathbf{a}_i^*, \mathbf{k}^*)$. This contradicts the fact that \mathbf{c}_i^* , $\boldsymbol{\theta}_i^*$, \mathbf{a}_i^* , and \mathbf{z}_i^* maximize $U_i(u_i(\mathbf{c}_i, \mathbf{k}^*), \boldsymbol{\theta}_i, \mathbf{a}_i, \mathbf{k}^*)$ subject to the same budget constraints, as they are part of an equilibrium of \mathcal{E} . This proves that the consumption levels and portfolios chosen at the equilibrium of \mathcal{E} also maximize utility in \mathcal{E}_0 .

Market clearing for goods, stocks, bonds, and state-contingent claims in \mathcal{E} directly implies market clearing in \mathcal{E}_0 . q.e.d.

The proof makes use of the fact that it is possible to maintain a given consumption vector \mathbf{c}_i for given changes in stocks and bonds holdings. This makes it clear that it is essential that financial assets guarantee completeness of the financial market independently of stock payoffs.

There are a multitude of other equilibria of \mathcal{E}_0 besides $(\mathbf{c}_i^*, \boldsymbol{\theta}_i^*, \mathbf{a}_i^*, \mathbf{z}_i^*)_{i=1}^I, \mathbf{k}^*, \mathbf{p}^*, \mathbf{v}^*, R^*$, and \mathbf{r}^* : if all consumers i but one, i' say, change their portfolios by arbitrary amounts $\Delta\theta_{ijl}$, Δa_{ijl} , and Δz_{is} such that (5) is satisfied and i' changes her portfolio by $\Delta\theta_{i'jl} = -\sum_{i \neq i'} \Delta\theta_{ijl}$, $\Delta a_{i'jl} = -\sum_{i \neq i'} \Delta a_{ijl}$, and $\Delta z_{i's} = -\sum_{i \neq i'} \Delta z_{is}$, then all consumers' consumption vectors are unchanged and an equilibrium prevails. Yet, there is no reason why the consumers should not stick to their SRI-motivated portfolios in \mathcal{E}_0 .

The separability condition can be replaced with an alternative assumption. Denote i 's utility function in \mathcal{E} as $U_i(\mathbf{c}_i, \boldsymbol{\theta}_i, \mathbf{a}_i, \mathbf{k})$, with no separability condition imposed, and denote her utility function in \mathcal{E}_0 as $u_i(\mathbf{c}_i, \mathbf{k})$.

Corollary 2: If

$$u_i(\mathbf{c}_i, \mathbf{k}^*) = U_i(\mathbf{c}_i, \boldsymbol{\theta}_i^*, \mathbf{a}_i^*, \mathbf{k}^*), \quad i = 1, \dots, I, \quad (6)$$

then the assertion of Theorem 1 holds true.

Proof: The proof is parallel to that of the Theorem 1. Only the next-to-last paragraph has to be adapted. Suppose there are \mathbf{c}_i , $\boldsymbol{\theta}_i$, \mathbf{a}_i , and \mathbf{z}_i satisfying the budget constraints such that $u_i(\mathbf{c}_i, \mathbf{k}^*) > u_i(\mathbf{c}_i^*, \mathbf{k}^*)$ for some i in \mathcal{E}_0 . From (6), $U_i(\mathbf{c}_i, \boldsymbol{\theta}_i^*, \mathbf{a}_i^*, \mathbf{k}^*) > U_i(\mathbf{c}_i^*, \boldsymbol{\theta}_i^*, \mathbf{a}_i^*, \mathbf{k}^*)$. But \mathbf{c}_i can also be achieved with stock holdings $\boldsymbol{\theta}_i^*$, bond holdings \mathbf{a}_i^* , and an appropriate portfolio of state-contingent claims in \mathcal{E} . This contradicts the fact that \mathbf{c}_i^* , $\boldsymbol{\theta}_i^*$, \mathbf{a}_i^* , and \mathbf{z}_i^* maximize $U_i(\mathbf{c}_i, \boldsymbol{\theta}_i, \mathbf{a}_i, \mathbf{k}^*)$ subject to the budget constraints. q.e.d.

Condition (6) implies that each consumer's ranking of consumption vectors without SRI considerations coincides with her ranking of consumption vectors in the presence of SRI given equilibrium stock and bond holdings. This condition is weaker than separability, which requires that the rankings are generally identical. But other than separability it depends on endogenous variables (viz., $(\boldsymbol{\theta}_i^*, \mathbf{a}_i^*)_{i=1}^I$ and \mathbf{k}^*).

To illustrate condition (6), consider the following example. For a subset of consumers $i = 1, \dots, \hat{I}$ ($\hat{I} < I$), the utility function in \mathcal{E} is

$$U_i(\mathbf{c}_i, \boldsymbol{\theta}_i, \mathbf{a}_i, \mathbf{k}) = u(c_{i0}) + \beta \sum_{s=1}^S \pi_s \frac{u(c_{i1s}, \dots, c_{iLs})}{1 + \sum_{l=1}^L \sum_{j'=1}^{\hat{J}_l} (\alpha_{ijl} \theta_{ijl} + \gamma_{ijl} a_{ijl})^2},$$

where u is an increasing function, π_s is the probability of state s , and β , the α_{ijl} 's, and the γ_{ijl} 's are positive constants. U_i captures an aversion against holding assets issued by the first \hat{J}_l ($\leq J_l$) l -producers. Let u_i be obtained by deleting the SRI-related terms from

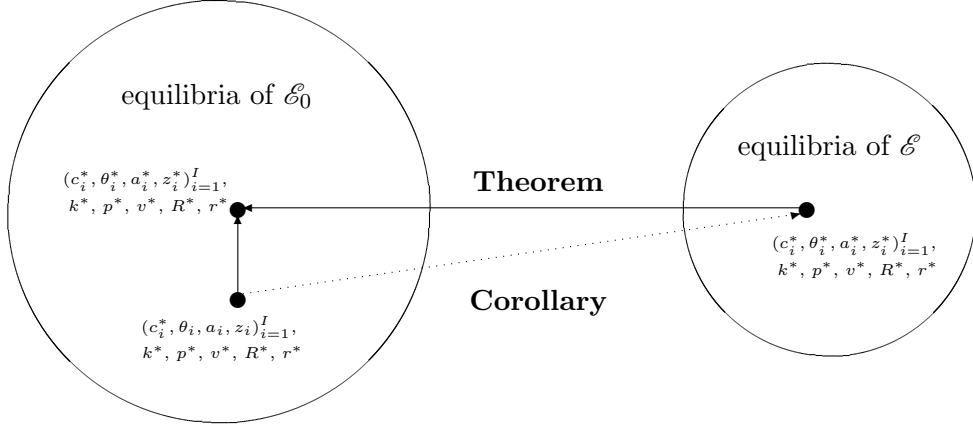


Figure 1: Corollary 3

U_i :

$$u_i(\mathbf{c}_i, \mathbf{k}) = u(c_{i0}) + \beta \sum_{s=1}^S \pi_s u(c_{i1s}, \dots, c_{iLs}).$$

For consumers $i = \hat{I} + 1, \dots, I$, the utility function is given by u_i both in \mathcal{E} and in \mathcal{E}_0 . Condition (6) is satisfied, because consumers $i = 1, \dots, \hat{I}$ choose $\theta_{ijl}^* = a_{ijl}^* = 0$ for $j = 1, \dots, \hat{J}_l$ at an equilibrium of \mathcal{E} and U_i does not depend on θ_{ijl} or $a_{ijl} = 0$ for $j = \hat{J}_l + 1, \dots, J_l$. Theorem 1 does not apply, since the function U_i is not separable. Corollary 2 nonetheless ensures neutrality of SRI.

Theorem 1 and Corollary 2 say that the removal of SRI is neutral under the respective conditions on the utility functions. The next corollary states conditions under which the converse also holds true, i.e., the introduction of SRI is neutral.

Corollary 3: If all variables except asset holdings $(\theta_i, \mathbf{a}_i, \mathbf{z}_i)_{i=1}^I$ are uniform across equilibria of \mathcal{E}_0 and the set of equilibria of \mathcal{E} is non-empty, then if $(\mathbf{c}_i^*, \theta_i, \mathbf{a}_i, \mathbf{z}_i)_{i=1}^I, \mathbf{k}^*, \mathbf{p}^*, \mathbf{v}^*, R^*$, and \mathbf{r}^* are an equilibrium of \mathcal{E}_0 , there is an equilibrium $(\mathbf{c}_i^*, \theta_i^*, \mathbf{a}_i^*, \mathbf{z}_i^*)_{i=1}^I, \mathbf{k}^*, \mathbf{p}^*, \mathbf{v}^*, R^*$, and \mathbf{r}^* of \mathcal{E} .

Proof: By assumption, all other equilibria of \mathcal{E}_0 differ from $(\mathbf{c}_i^*, \theta_i, \mathbf{a}_i, \mathbf{z}_i)_{i=1}^I, \mathbf{k}^*, \mathbf{p}^*, \mathbf{v}^*, R^*$, and \mathbf{r}^* only with regard to asset holdings $(\theta_i, \mathbf{a}_i, \mathbf{z}_i)_{i=1}^I$. By virtue of Theorem 1, one of them, $(\mathbf{c}_i^*, \theta_i^*, \mathbf{a}_i^*, \mathbf{z}_i^*)_{i=1}^I, \mathbf{k}^*, \mathbf{p}^*, \mathbf{v}^*, R^*$, and \mathbf{r}^* say, is also an equilibrium of \mathcal{E} (see Figure 1). q.e.d.

The reason why the additional assumptions are necessary is that the introduction of SRI

may “destroy” an equilibrium of \mathcal{E}_0 . To see this, assume consumer i ’s utility function is

$$U_i(u_i(\mathbf{c}_i, \mathbf{k}), \boldsymbol{\theta}_i, \mathbf{a}_i, \mathbf{k}) = u_i(\mathbf{c}_i, \mathbf{k}) + \alpha\theta_{i11}$$

with $\alpha > 0$, i.e., i has a preference for holding stocks of the first producer of the first good. In \mathcal{E} , starting from any consumption and portfolio choice that satisfies the budget constraints, let i change her demand for stocks of the first producer of the first good by $\Delta\theta_{i11} > 0$ and adjust \mathbf{z}_i according to (5), so that her consumption vector \mathbf{c}_i is unaffected. Then, since $u_i(\mathbf{c}_i, \mathbf{k})$ is constant and $\alpha\theta_{i11}$ goes up, U_i rises. This is incompatible with existence of equilibrium. That is why Corollary 3 requires existence of equilibrium for \mathcal{E} . A second problem, which arises when equilibria of \mathcal{E}_0 differ with regard to $(\mathbf{c}_i^*)_{i=1}^I, \mathbf{k}^*, \mathbf{p}^*, \mathbf{v}^*, R^*$, or \mathbf{r}^* , is that the introduction of SRI may “destroy” those equilibria of \mathcal{E}_0 for which an equilibrium of \mathcal{E} with the same values of $(\mathbf{c}_i^*)_{i=1}^I, \mathbf{k}^*, \mathbf{p}^*, \mathbf{v}^*, R^*$, and \mathbf{r}^* exists, so that one cannot apply Theorem 1 in the proof of the corollary.

Theorem 1 and the corollaries say that SRI is neutral unless it also has an impact on agents’ consumption choices (i.e., separability does not hold), which is a rather obvious caveat, as higher demand for acceptable goods, of course, raises the amount of resources devoted to their production (cf. Davidson et al., 1995, pp. 187–8, Angel and Rivoli, 1997, p. 58).

Theorem 1 and Corollaries 2 and 3 apply without modification if consumers supply capital to firms proportionally to their post-trade ownership shares θ_{ijl} . This reduces the value of the firm for buyers of shares by p_0k_{jl} . While the date-1 budget constraints (2) remain unchanged, the date-0 budget constraint becomes

$$\begin{aligned} p_0(c_{i0} - y_{i0}) &+ \sum_{l=1}^L \sum_{j=1}^{J_l} \{\theta_{ijl} (p_0k_{jl} - Rb_{jl}) \\ &+ (\theta_{ijl} - \bar{\theta}_{ijl}) [v_{jl} - (p_0k_{jl} - Rb_{jl})] + Ra_{ijl}\} + \sum_{s=1}^S r_s z_{is} \leq 0. \end{aligned}$$

Rearranging terms yields (1). Consumer i ’s contribution to firm j ’s capital formation changes by $(\theta_{ijl} - \bar{\theta}_{ijl})(p_0k_{jl} - Rb_{jl})$. This is exactly compensated by the fact that the market value of the firm drops from v_{jl} to $v_{jl} - (p_0k_{jl} - Rb_{jl})$, i.e., the value of the date-1 cash flow minus the stockholders’ date-0 capital contributions.

Theorem 1 and the corollaries also apply without modification if other financial assets than state-contingent claims guarantee financial market completeness. Consider M finan-

cial assets $m = 1, \dots, M$ with payoffs x_{ms} in states $s = 1, \dots, S$. Suppose asset m costs $\sum_{s=1}^S r_s^* x_{ms}$. Let the financial market be complete in that for any given vector of payoffs (t_1, \dots, t_S) , there is a portfolio (w_1, \dots, w_M) such that $\sum_{m=1}^M x_{ms} w_m = t_s$ for all s . The cost of this portfolio is the same as the cost of the state-contingent claims portfolio that yields payoffs (t_1, \dots, t_S) :

$$\sum_{m=1}^M \left(\sum_{s=1}^S r_s^* x_{ms} \right) w_m = \sum_{s=1}^S r_s^* t_s.$$

So for arbitrary changes in i 's stock and bond holdings $\Delta\theta_{ijl}$ and Δa_{ijl} , there exist changes in w_m which leave c_{ils} unaffected, and the total change in the cost of i 's portfolio is zero, so that c_{i0} is also unaffected. The proof of Theorem 1 goes through without further modification.

5 One-good representative agent model

This section considers the one-good representative agent version of the model. We first consider the model with complete financial markets, which is a tractable special case of the general model of Section 2. We then analyze an incomplete markets version of the model, which we use in Section 6 to relate our model to the existing literature on the non-neutrality of SRI.

5.1 Model

There is only one good at date 1 (i.e., $L = 1$), so we drop the index for goods l . The firms' production functions $f_{js}(k_j)$ satisfy $f'_{js}(k_j) > 0 > f''_{js}(k_j)$ and $f'_{js}(0) = \infty$. All firms issue the same amount of debt b_j . Consumers have uniform endowments of goods y_{i0} and stocks ($\bar{\theta}_{ij} = 1/I$) and the same time-separable consumption utility function $u_i(\mathbf{c}_i) = u(c_{i0}) + \beta \sum_{s=1}^S \pi_s u(c_{is})$, where $u'(c) > 0 > u''(c)$, $u'(0) = \infty$, and $\beta > 0$. There are no externalities, so \mathbf{k} is dropped from u_i . Consumers $i = 1, \dots, \hat{I}$ ($\hat{I} < I$) are socially responsible investors (SR investors). They care about their holdings of assets issued by the first \hat{J} ($\leq J$) firms. Their overall utility function $U_i(u_i(\mathbf{c}_i), \boldsymbol{\theta}_i, \mathbf{a}_i, \mathbf{k})$ is differentiable. For all u_i and \mathbf{k} , there exist unique values θ_{ij} and a_{ij} ($j = 1, \dots, \hat{J}$) which maximize U_i ($i = 1, \dots, \hat{I}$), denoted $\hat{\theta}_{ij}$ and \hat{a}_{ij} , respectively. Generally, the $\hat{\theta}_{ij}$'s and \hat{a}_{ij} 's depend on

u_i and \mathbf{k} . An example in which they are constants is

$$U_i(u_i(\mathbf{c}_i), \boldsymbol{\theta}_i, \mathbf{a}_i, \mathbf{k}) = u(\mathbf{c}_i) + \sum_{j=1}^{\hat{J}} \mathbf{1}_{k_j \leq \hat{k}_j} \left[\alpha_{ij} \left(2\theta_{ij} - \frac{\theta_{ij}^2}{\hat{\theta}_{ij}} \right) + \gamma_{ij} \left(2a_{ij} - \frac{a_{ij}^2}{\hat{a}_{ij}} \right) \right] \quad (7)$$

(where $\mathbf{1}_x$ is the indicator function, taking on the value one if inequality x is satisfied and zero otherwise). That is, if firm j 's capital stock does not exceed a maximum acceptable level \hat{k}_j (> 0), holding a fraction $\hat{\theta}_{ij}$ of its shares and \hat{a}_{ij} of its bonds gives SR investors extra utility $\alpha_{ij}\hat{\theta}_{ij} + \gamma_{ij}\hat{a}_{ij}$. Consumers $i = \hat{I} + 1, \dots, I$ are called purely financially motivated investors (FM investors). Their overall utility is $u_i(\mathbf{c}_i)$. As before, there are no short sale constraints. The spot prices are normalized to unity: $p_0 = 1$ and $p_s = 1$, $s = 1, \dots, S$.

5.2 Complete markets

Suppose that, as before, there is trade in state-contingent claims for all S states. Then the model is the one-good representative-agent special case of the general model \mathcal{E} of Section 2.

The necessary conditions for a utility maximizing choice of $\boldsymbol{\theta}_i$, \mathbf{a}_i , and \mathbf{z}_i are

$$\frac{\partial U_i}{\partial u_i} \left[-u'(c_{i0})v_j + \sum_{s=1}^S \beta \pi_s u'(c_{is})(y_{js} - b_j) \right] + \mathbf{1}_{i \leq \hat{I}} \mathbf{1}_{j \leq \hat{J}} \frac{\partial U_i}{\partial \theta_{ij}} = 0 \quad (8)$$

$$\frac{\partial U_i}{\partial u_i} \left[-u'(c_{i0})R + \sum_{s=1}^S \beta \pi_s u'(c_{is}) \right] + \mathbf{1}_{i \leq \hat{I}} \mathbf{1}_{j \leq \hat{J}} \frac{\partial U_i}{\partial a_{ij}} = 0 \quad (9)$$

for $j = 1, \dots, J$ and

$$-u'(c_{i0})r_s + \beta \pi_s u'(c_{is}) = 0 \quad (10)$$

for $s = 1, \dots, S$. SR investors $i = 1, \dots, \hat{I}$ choose their asset holdings such that $\partial U_i / \partial \theta_{ij} = 0$ and $\partial U_i / \partial a_{ij} = 0$ for $j = 1, \dots, \hat{J}$. Otherwise they could raise utility with a marginal change in θ_{ij} and/or a_{ij} in the direction of a positive partial effect on U_i , adapting \mathbf{z}_i according to (5) so that consumption \mathbf{c}_i is unaffected. So the $\partial U_i / \partial \theta_{ij}$ and $\partial U_i / \partial a_{ij}$ terms drop out of (8) and (9), respectively, and one obtains the standard necessary optimality conditions, which also apply to FM investors. Accordingly, we focus on equilibria of \mathcal{E} , in which all i choose the same consumption vector: $c_{i0} = y_{i0} - (1/I) \sum_{j=1}^J k_j$ and $c_{is} = (1/I) \sum_{j=1}^J f_{js}(k_j)$. Using this and (10), one can rewrite the condition for value

maximization $1 = \sum_{s=1}^S r_s f'_{js}(k_j)$ as

$$u' \left(y_{i0} - \frac{1}{I} \sum_{j'=1}^J k_{j'} \right) = \sum_{s=1}^S \beta \pi_s f'_{js}(k_j) u' \left(\frac{1}{I} \sum_{j'=1}^J f_{j's}(k_{j'}) \right), \quad j = 1, \dots, J. \quad (11)$$

An equilibrium of \mathcal{E} is characterized as follows. The capital stocks \mathbf{k}^* are determined as a solution to (11). Evaluating the arguments of the marginal utility function in (11) yields \mathbf{c}_i^* . The necessary conditions for utility maximization can then be used to solve for the equilibrium asset prices:

$$v_j^* = E \{ m^* [f_j(k_j^*) - b_j] \}, \quad R^* = E(m^*), \quad r_s^* = \pi_s m_s^*, \quad s = 1, \dots, S, \quad (12)$$

where

$$m_s = \beta \frac{u'(c_{is})}{u'(c_{i0})} \quad (13)$$

is the stochastic discount factor (SDF) and m_s^* is m_s evaluated at \mathbf{c}_i^* for any i (E is the expectations operator and a random variable with realizations x_s in s is denoted x). The SR investors' demands for the assets issued by firms $j = 1, \dots, \hat{J}$ are $\theta_{ij}^* = \hat{\theta}_{ij}$ and $a_{ij}^* = \hat{a}_{ij}$. Each FM investor $i = \hat{I} + 1, \dots, I$ holds a fraction $\theta_{ij}^* = (1 - \sum_{i'=1}^{\hat{I}} \theta_{i'j}^*) / (I - \hat{I})$ of and buys $a_{ij}^* = (b_j - \sum_{i'=1}^{\hat{I}} a_{i'j}^*) / (I - \hat{I})$ bonds issued by these firms. For firms $j = \hat{J} + 1, \dots, J$ we have $\theta_{ij}^* = 1/I$ and $a_{ij}^* = b_j/I$ for each consumer $i = 1, \dots, I$. The contingent claims demands \mathbf{z}_i^* are obtained from the consumers' date-1 budget constraints (2) (holding with equality).

The model is simplified further by assuming that firms are homogeneous, i.e., the production function $f_{js}(k_j) = f_s(k_j)$ is uniform across j in each state s . All firms choose the same capital stock k_j , determined by (11) then. As the left-hand side of (11) is increasing and goes to infinity as $k_j \rightarrow I y_{i0}/J$ and the right-hand side is decreasing and goes to infinity as $k_j \rightarrow 0$, there is a unique solution k_j in this special case. If utility is logarithmic (i.e., $u(c) = \log c$) and production is Cobb-Douglas with multiplicative shocks (i.e., $f_{js}(k_j) = \lambda_s k_j^\gamma$ with $0 < \gamma < 1$), then there is a closed-form solution for the equilibrium capital stock:

$$k_j = \frac{\beta \gamma}{1 + \beta \gamma} \frac{I}{J} y_{i0}. \quad (14)$$

For $S = 1$, one obtains the standard representative-agent intertemporal model without uncertainty, which has the well-known neat graphical interpretation: the representative consumer's equilibrium consumption levels c_{i0}^* and c_{i1}^* are determined as the coordinates

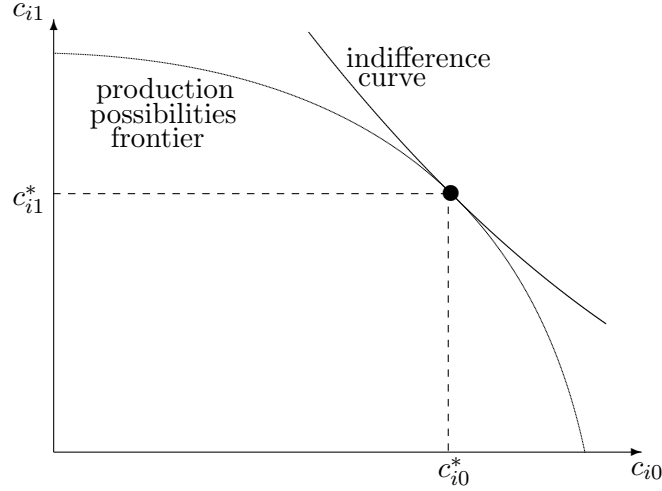


Figure 2: Example

of the tangency point of the production possibilities frontier $c_{i1} = (J/I)f_1((I/J)(y_{i0} - c_{i0}))$ and an indifference curve (see Figure 2) and $-1/R^*$ is the common slope of the curves there.⁶

From Theorem 1, it follows that the equilibrium of \mathcal{E} is an equilibrium of \mathcal{E}_0 as well. There is also a symmetric equilibrium of \mathcal{E}_0 at which each consumer i holds fractions $(\theta_{ij} = a_{ij}/b_j =) 1/I$ of the shares and bonds issued by each firm $j = 1, \dots, J$ and there is no trade in state-contingent claims. The fact that the equilibrium with SRI is also an equilibrium of \mathcal{E}_0 is due to the fact that \mathbf{c}_i does not change when, starting from the symmetric equilibrium, consumers change their asset holdings by $\Delta\theta_{ij} = \theta_{ij}^* - 1/I$, $\Delta a_{ij} = a_{ij}^* - b_j/I$, and $\Delta z_{is} = -\sum_{j=1}^J [\Delta\theta_{ij}(y_{js} - b_j) + \Delta a_{ij}]$. In the special case with homogeneous firms, the conditions of Corollary 3 are satisfied: equilibrium resource allocation and prices are uniquely determined in \mathcal{E}_0 , and an equilibrium of \mathcal{E} exists. So the introduction of SRI is neutral.

5.3 Incomplete markets

To study market incompleteness, we focus on the simple case with no markets for state-contingent claims at all. Denote the resulting variant of the one-good representative agent model as \mathcal{E}' and the corresponding economy without SRI considerations as \mathcal{E}'_0 . An equilibrium of \mathcal{E}' is defined as in Section 3, except that all terms relating to state-

⁶See Obstfeld and Rogoff (1996, Section 1.2).

contingent claims and the corresponding market clearing conditions drop out.

There is one special case in which, even though the Theorem 1 is not applicable, an analogous neutrality result holds, viz., if firms are homogeneous in that they each has the same production function f_s . In this case, stocks issued by different firms are perfect substitutes, so that there is no reason why investors should not bias their portfolios towards certain stocks at an equilibrium of \mathcal{E}'_0 :

Proposition 4: Let $f_{js} = f_s$ be uniform across j for all s and $\hat{J} < J$. If $(\mathbf{c}_i^*, \boldsymbol{\theta}_i^*, \mathbf{a}_i^*)_{i=1}^I$, \mathbf{k}^* , \mathbf{v}^* , and R^* are an equilibrium of \mathcal{E}' and \mathbf{c}_i^* is uniform across consumers i , then they are an equilibrium of \mathcal{E}'_0 .

Proof: The fact that \mathbf{c}_i^* is uniform across i implies that the SDF m^* is uniquely determined in \mathcal{E}' . SR investors choose $\theta_{ij}^* = \hat{\theta}_{ij}$ and $a_{ij}^* = \hat{a}_{ij}$, so that $\partial U_i / \partial \theta_{ij} = 0$ and $\partial U_i / \partial a_{ij} = 0$ for $j = 1, \dots, \hat{J}$ in (8) and (9). Rearranging terms in (8) and using the definition of the SDF in (13) yields

$$v_j = E \{ m^* [f(k_j) - b_j] \}.$$

Maximization of $v_j - (k_j - R^* b_j)$ yields $E[m^* f'(k_j^*)] = 1$. So the capital stock k_j^* , the output levels $y_{js}^* = f_s(k_j^*)$ are uniform across firms j . Firms' market capitalization v_j^* and the inverse of the safe interest rate R^* are given by the first and third equality in (12), respectively.

Given that m^* , v_j^* , and R^* are the same as in \mathcal{E}' , firms choose the same capital stock and consumers face the same budget constraints in \mathcal{E}'_0 . Suppose there are \mathbf{c}_i , $\boldsymbol{\theta}_i$ and \mathbf{a}_i satisfying the budget constraints in \mathcal{E}'_0 such that $u_i(\mathbf{c}_i) > u_i(\mathbf{c}_i^*)$. \mathbf{c}_i can also be attained with the portfolio

$$\left(\theta_{i1}^*, \dots, \theta_{i(J-1)}^*, \sum_{j=1}^J \theta_{ij} - \sum_{j=1}^{J-1} \theta_{ij}^*, a_{i1}^*, \dots, a_{i(J-1)}^*, \sum_{j=1}^J a_{ij} - \sum_{j=1}^{J-1} a_{ij}^* \right), \quad (15)$$

which entails the same investments in firms $j = 1, \dots, J-1$ as the equilibrium portfolio in \mathcal{E}' . This follows from the budget constraints (1) and (2) (without the z_{is} terms): given that v_j^* is uniform across j , the cost of i 's portfolio at date 0 depends only on $\sum_{j=1}^J \theta_{ij}$ and $\sum_{j=1}^J a_{ij}$ and not on the individual terms in the sums; and given that y_{js}^* is uniform across j in each state s , the same holds true for the portfolio payoffs at date 1. As U_i depends only on the first $\hat{J} (< J)$ components of $\boldsymbol{\theta}_i$ and \mathbf{a}_i , financing \mathbf{c}_i with the portfolio in (15) yields $U_i(u_i(\mathbf{c}_i), \boldsymbol{\theta}_i^*, \mathbf{a}_i^*, \mathbf{k}^*) > U_i(u_i(\mathbf{c}_i^*), \boldsymbol{\theta}_i^*, \mathbf{a}_i^*, \mathbf{k}^*)$. This contradicts the fact that \mathbf{c}_i^* , $\boldsymbol{\theta}_i^*$, and \mathbf{a}_i^* maximize $U_i(u_i(\mathbf{c}_i), \boldsymbol{\theta}_i, \mathbf{a}_i, \mathbf{k}^*)$ subject to the same budget constraints. This

confirms that \mathbf{c}_i^* and m^* are in fact the same in \mathcal{E}'_0 as in \mathcal{E}' . q.e.d.

This non-neutrality result for the case of market completeness is a second generalization of the neutrality result for the case of no uncertainty sketched in the Introduction.

6 Non-neutrality of SRI

In this section we generate non-neutrality results by modifying the incomplete markets version of the one-good representative agent model of Section 5 and relate them to the existing literature.

6.1 Non-satiation: voting with our feet

To begin with, we consider a model variant that yields a non-neutrality result analogous to Gollier and Pouget's (2014, Subsection 2.2) "voting with our feet" result. The key assumptions underlying the result are non-satiation with regard to SRI-motivated asset holdings and market incompleteness.

SR investors' utility function is:

$$U_i(u_i(\mathbf{c}_i), \boldsymbol{\theta}_i, \mathbf{a}_i, \mathbf{k}) = u_i(\mathbf{c}_i) + \sum_{j=1}^{\hat{J}} \mathbf{1}_{k_j \leq \hat{k}_j} \alpha_j \theta_{ij}$$

with $\alpha_j > 0$ for $j = 1, \dots, \hat{J}$. That is, SR investors derive a constant extra benefit per unit of stock held, in addition to the financial payoff, obtained from investing in a pro-social firm j , which restricts its capital stock to below \hat{k}_j . Contrary to Section 5, an investment level $\hat{\theta}_{ij}$ at which i 's SRI-motivated appetite for j 's stocks is satiated does not exist (cf. (7)). Firms are homogeneous (i.e., $f_{js}(k_j) = f_s(k_j)$).

By the argument put forward in the remarks to Corollary 3, an equilibrium at which SRI is operative, i.e., at which $k_j \leq \hat{k}_j$ for some $j = 1, \dots, \hat{J}$, does not exist with complete financial markets. This is because an SR investor i could increase her utility by increasing θ_{ij} for j and undoing the impact on consumption with appropriate trades of state-contingent claims, given by (5).

Consider the incomplete markets version \mathcal{E}' of the model. Suppose for simplicity that $\hat{I} = I$ and $\hat{J} = J$, i.e., all consumers care about each firm's behavior. An equilibrium of \mathcal{E}' with non-neutrality of SRI $(\mathbf{c}_i^*, \boldsymbol{\theta}_i^*, \mathbf{a}_i^*)_{i=1}^I, \mathbf{k}^*, \mathbf{v}^*$, and R^* is constructed as follows. Let each firm j choose the capital stock $k_j^* = \hat{k}_j$. Each consumer chooses $\theta_{ij}^* = 1/I$, $a_{ij}^* = b_j/I$,

$c_{i0}^* = y_{i0} - (J/I)k_j^*$, and $c_{is}^* = (J/I)f_s(k_j^*)$. The budget constraints are satisfied and the markets for stocks, bonds, and goods clear. The asset prices are

$$v_j^* = E \left\{ m^* [f(k_j^*) - b_j] \right\} + \frac{\alpha_j}{u'(c_{i0}^*)}$$

and $R^* = E(m^*)$. These asset pricing equations imply that the necessary conditions (8) and (9) for an optimal choice of θ_{ij} and a_{ij} , respectively, are satisfied. Two further conditions are required in order to make sure that firms also maximize. Let k'_j denote the capital stock that maximizes $E\{m^*[f(k_j) - b_j]\} - (k_j - Rb_j)$. First, we must have $\hat{k}_j \leq k'_j$ for all j , since otherwise a decrease in k_j would increase $v_j - (k_j - Rb_j)$. Second, a firm must not gain by raising the capital stock from \hat{k}_j to k'_j , i.e., by giving up pro-social behavior. As before, we assume that a firm perceives itself as small in that a change in its capital stock does not affect the SDF m . On the other hand, the firm takes into account that consumers' extra willingness to pay α_j is dependent on pro-social firm behavior. So the change in the firm's value induced by giving up the pro-social business model is

$$E \left\{ m^* [f(k'_j) - f(k_j^*)] \right\} - \frac{\alpha_j}{u'(c_{i0}^*)}.$$

In order for an equilibrium to prevail, this has to be non-positive. As an example, let $\hat{k}_j = k'_j/\mu$ with $\mu > 1$. Then, with log utility (i.e., $u(c) = \log c$) and a Cobb-Douglas production with multiplicative shocks (i.e., $f_s(k_j) = \lambda_s k_j^\gamma$ with $0 < \gamma < 1$) this condition states that the extra willingness to pay for j 's stocks α_j must not fall short of $\beta(\mu^\gamma - 1)(I/J)E(1/\lambda_s)$. This proves:

Proposition 5: If SR consumers' preferences are non-satiated in asset holdings, an equilibrium of \mathcal{E}' is not necessarily an equilibrium of \mathcal{E}'_0 .

The equilibrium of \mathcal{E}' with $k_j^* = \hat{k}_j$ is a variant of Gollier and Pouget's (2014, Proposition 1, p. 8) "voting-with-our-feet" equilibrium: SR investors' threat to walk away from firms that give up their pro-social business model provides the firms with incentives to maintain pro-social behavior. Our approach makes it clear that incompleteness of the financial market is a crucial assumption underlying the result, as the assumed preferences are incompatible with equilibrium with complete markets. Gollier and Pouget (2014, Subsection 2.3) further show that shareholder activism strengthens their result. If the decision to behave in a pro-social manner is made after trade in shares on the basis of one-share-one-vote, then the fact that SR investors hold more shares in firms with pro-

social behavior helps them to vote for that very behavior (unlike in our model, not all consumers are pro-social in their model). A similar model is used by Dam and Scholtens (2015) to analyze the impact of SRI on different measures of financial performance, reconciling the observations that SRI is associated with high market-to-book values but not generally with higher stock returns.

6.2 Short sale constraints: shareholder boycott

This subsection proves a version of Heinkel et al.'s (2001) result that in the presence of short sale constraints the threat of a shareholder boycott can induce firms to choose a “green” business model .

Let I and J be even. Let half of the consumers be socially responsible ($\hat{I} = I/2$). Their utility function is

$$U_i(u_i(\mathbf{c}_i), \boldsymbol{\theta}_i, \mathbf{a}_i, \mathbf{k}) = u_i(\mathbf{c}_i) - \sum_{j=1}^J \mathbf{1}_{k_j > \hat{k}} \mathbf{1}_{\theta_{ij} > 0} \alpha_j,$$

where $\alpha_j > 0$ is prohibitively large, so that no SR consumer holds a positive amount of shares of a firm j with capital stock $k_j > \hat{k}$ (for instance, α_j exceeds the maximum level of $u_i(\mathbf{c}_i)$ that can be achieved when all the economy's resources are used to maximize i 's utility). Consumption utility is logarithmic (i.e., $u(c) = \log c$). Firms are homogeneous, shocks are multiplicative, and production is Cobb-Douglas (i.e., $f_{js}(k_j) = \lambda_s k_j^\gamma$ with $0 < \gamma < 1$). For simplicity, firms issue no debt: $b_j = 0$ for all j . Importantly, it is not allowed to sell stocks short: the θ_{ij} 's must not be negative.

With complete financial markets, the analysis in Section 4 applies without modification: from Theorem 1, an equilibrium of \mathcal{E} with short sale constraints is also an equilibrium of \mathcal{E}_0 . The results in Subsection 5.2 hold with one minor modification: the partial derivatives of U_i with respect to u_i and θ_{ij} drop out of the condition for an optimal choice of θ_{ij} (see (8)); instead SR investors choose $\theta_{ij} = 0$ if $k_j > \hat{k}$. Firms' uniform capital stock k_j is uniquely given by (14). Hence, $(\mathbf{c}_i^*)_{i=1}^I$, \mathbf{v}^* , R^* , and \mathbf{r}^* are also uniquely determined (see (12)). So the conditions of Corollary 3 are satisfied. Both giving up as well as introducing SRI are neutral.

Now consider the incomplete markets version \mathcal{E}' of the model, with no trade in state-contingent claims. Let

$$\frac{I}{J} y_{i0} > \left(\frac{1}{\beta\gamma} + 1 \right) \hat{k}. \quad (16)$$

Then the following allocation and prices constitute an equilibrium. One half of the firms ($j = 1, \dots, J/2$, say) choose the maximum capital stock \hat{k} that leaves them acceptable for socially responsible consumers. The other half choose the capital stock

$$k^* = \frac{\frac{I}{J}y_{i0} - \frac{\hat{k}}{2}}{\frac{1}{\beta\gamma} + \frac{1}{2}}, \quad j = \frac{J}{2} + 1, \dots, J. \quad (17)$$

SR investors hold all the shares issued by responsible firms and no stocks of the other firms. So $\theta_{ij}^* = 2/I$ for $j = 1, \dots, J/2$ and $i = 1, \dots, \hat{I}$ and for $j = J/2 + 1, \dots, J$ and $i = \hat{I} + 1, \dots, I$, whereas $\theta_{ij}^* = 0$ for $j = J/2 + 1, \dots, J$ and $i = 1, \dots, \hat{I}$ and for $j = 1, \dots, J/2$ and $i = \hat{I} + 1, \dots, I$. All individuals consume

$$c_{i0}^* = y_{i0} - \frac{J k^* + \hat{k}}{I} \frac{1}{2}$$

at date 0. The date-1 consumption levels are

$$c_{is}^* = \frac{J}{I} \lambda_s \hat{k}^\gamma, \quad i = 1, \dots, \hat{I} \quad (18)$$

$$c_{is}^* = \frac{J}{I} \lambda_s (k^*)^\gamma, \quad i = \hat{I} + 1, \dots, I. \quad (19)$$

All firms have the same value

$$v_j^* = \frac{I}{J} \beta c_{i0}^*. \quad (20)$$

Evidently, the goods and stock markets clear, and the consumption vectors \mathbf{c}_i^* satisfy the budget constraints (1) and (2) (with $a_{ij} = z_{is} = 0$) with equality. To show that an equilibrium prevails, we have to show that consumers and firms optimize.

Consider first firms $j = 1, \dots, J/2$. These green firms choose the capital stock \hat{k} and are owned by the SR investors $i = 1, \dots, \hat{I}$. From the SR investors' $i = 1, \dots, \hat{I}$ necessary conditions for an optimal choice of θ_{ij} (8),

$$v_j = E(m^* \lambda k_j^\gamma), \quad (21)$$

where m^* is their SDF. Substituting the definition of the SDF (13), $k_j = \hat{k}$, and the consumption levels c_{is}^* from (18) into (21) yields (20). Next, consider firms $j = J/2 + 1, \dots, J$, which choose k^* and are owned by FM investors. These non-green firms' value is given by (21) with m^* as the SDF of consumers $i = \hat{I} + 1, \dots, I$. Using the definition

of the SDF (13) and (19),

$$v_j = \frac{I}{J} \beta c_{i0}^* \left(\frac{k_j}{k^*} \right)^\gamma.$$

As all firms $j = J/2 + 1, \dots, J$ choose the same capital stock $k_j (= k^*)$, maximization of $v_j - k_j$ yields (17), and the uniform firm value is given by (20). Condition (16) ensures that $k^* > \hat{k}$. As all firms have the same value v_j^* , no firm has incentive to change its business model (from green to non-green or vice versa).

For SR investors, who refrain from holding non-green firms' stocks, the validity of the asset pricing equations for green firms implies utility maximization. For an FM investor, the impact of a marginal change $d\theta_{ij}$ in her holdings of stocks of a green firm j on her utility is

$$-u'(c_{i0}^*) \left[v_j^* - E \left(m^* \lambda \hat{k} \right) \right] d\theta_{ij},$$

where m^* is her SDF. The term in square brackets is zero if m^* is the green investors' SDF instead (cf. (21)), which is larger in each state, since c_{is}^* is lower in each state (see (18) and (19)). Hence, the term in square brackets is strictly negative, and the change in utility is strictly positive for $d\theta_{ij} < 0$. That is why the short selling constraint for stocks is required in order to make zero investments in green stocks optimal for FM investors.

This example proves:

Proposition 6: If short selling is constrained, an equilibrium of \mathcal{E}' is not necessarily an equilibrium of \mathcal{E}'_0 .

This proposition is a version of Heinkel et al.'s (2001) non-neutrality result. Mackey et al. (2007) obtain a similar result in a setup with no uncertainty. Vanwalleghem (2017) shows that asymmetric information about the cash flow effects of switching to green production has a negative impact on the incentives to do so if FM investors believe that there are no cash flow effects beyond the direct cost of reforming the firm. The proportion of green firms is a function of the proportion of green investors in Heinkel et al. (2001) (while we confine attention to the case where both are one-half). Using a numerical version of their model, Heinkel et al. (2001) conclude that the proportion of green investors has to exceed 20 percent in order for the first firms to go green (a figure cited, e.g., by Wagemans et al., 2013, p. 244; Dam and Scholtens, 2015, p. 105; Vanwalleghem, 2017, p. 10). Our model raises the caveat that irrespective of the frequency of SR investors, SRI is neutral unless the financial market is incomplete.

6.3 Idiosyncratic shocks

According to Proposition 4, SRI is neutral even if the financial market is incomplete if firms experience identical multiplicative productivity shocks. This subsection shows that SRI is not necessarily neutral if the productivity shocks are not perfectly correlated.

Production is Cobb-Douglas with multiplicative productivity shocks: $f_{js}(k_j) = \lambda_{js}k_j^\gamma$. The λ_j 's are now i.i.d. random variables (rather than uniform across firms). Consumers have constant relative risk aversion σ : $u(c) = c^{1-\sigma}/(1-\sigma)$, where

$$\sigma > 1 - \frac{1}{\gamma}. \quad (22)$$

With complete financial markets the model is a simple special case of the model of Sections 2–4. Theorem 1 applies, SRI is neutral. The capital stock k_j is uniform across firms j and determined by (11), which can be written as

$$\frac{1}{(y_{i0} - \frac{J}{I}k_j)^\sigma} = \frac{\beta\gamma}{(\frac{J}{I})^\sigma k_j^{1+\gamma(\sigma-1)}} \sum_{s=1}^S \pi_s \left(\frac{1}{J} \sum_{j'=1}^J \lambda_{j's} \right)^{1-\sigma} \quad (23)$$

here, where use is made of the fact that, since the λ_j 's are i.i.d.,

$$\begin{aligned} \mathbb{E} \left[\frac{\lambda_{js}}{\left(\frac{1}{J} \sum_{j'=1}^J \lambda_{j's} \right)^\sigma} \right] &= \frac{1}{J} \sum_{j=1}^J \mathbb{E} \left[\frac{\lambda_{js}}{\left(\frac{1}{J} \sum_{j'=1}^J \lambda_{j's} \right)^\sigma} \right] \\ &= \mathbb{E} \left[\frac{\frac{1}{J} \sum_{j=1}^J \lambda_{js}}{\left(\frac{1}{J} \sum_{j'=1}^J \lambda_{j's} \right)^\sigma} \right] = \mathbb{E} \left[\left(\frac{1}{J} \sum_{j'=1}^J \lambda_{j's} \right)^{1-\sigma} \right]. \end{aligned}$$

Condition (22) ensures that the right-hand side of (23) is a decreasing function of k_j , so that a unique solution exists. With log utility (i.e., setting $\sigma = 1$) one obtains (14), i.e., the capital stock is the same as in the case of perfectly correlated productivity shocks. This is the standard result that if the coefficient of relative risk aversion is equal to unity, the return distribution does not affect capital formation.

Turning to the incomplete markets model with no markets for state contingent claims, assume that each consumer boycotts stocks of a subset of firms which are considered non-acceptable:

$$U_i(u_i(\mathbf{c}_i), \boldsymbol{\theta}_i, \mathbf{a}_i, \mathbf{k}) = u_i(\mathbf{c}_i) - \sum_{j \notin J_i} \mathbf{1}_{k_j > \hat{k}} \mathbf{1}_{\theta_{ij} > 0} \alpha_j,$$

where J_i is the set of firms acceptable for i and α_j is prohibitive. To preserve symmetry, the sets J_i have the same cardinality $\#J_i = \hat{J} (< J)$, and each firm j is contained in \hat{J} of the sets. For $j \in J_i$, the number of stocks held by i is $\theta_{ij} = (J/\hat{J})/I$. As stocks are the only source of date-1 income, i 's consumption in state s is $c_{is} = (J/\hat{J})(1/I) \sum_{j \in J_i} y_{js}$ and the SDF is

$$m_s = \beta \left(\frac{\frac{1}{J} y_{i0} - k_j}{\frac{1}{\hat{J}} \sum_{j' \in J_i} \lambda_{j's}} \right)^\sigma.$$

Inserting this into $1 = \gamma E(m \lambda k_j^{\gamma-1})$ (the condition for maximization of $v_j - k_j$) yields

$$\frac{1}{(y_{i0} - \frac{J}{I} k_j)^\sigma} = \frac{\beta \gamma}{(\frac{J}{I})^\sigma k_j^{1+\gamma(\sigma-1)}} \sum_{s=1}^S \pi_s \left(\frac{1}{\hat{J}} \sum_{j'=1}^{J_i} \lambda_{j's} \right)^{1-\sigma} \quad (24)$$

The only difference compared to (23) is that the weighted sum on the right-hand side contains fewer i.i.d. random variables $\lambda_{j'}$. From Jensen's inequality and the law of large numbers,

$$E \left[\left(\frac{1}{J} \sum_{j'=1}^J \lambda_{j's} \right)^{1-\sigma} \right] < E \left[\left(\frac{1}{J} \sum_{j'=1}^J \lambda_{j's} \right) \right]^{1-\sigma} = \left(\lim_{j \rightarrow \infty} \frac{1}{J} \sum_{j'=1}^J \lambda_{j's} \right)^{1-\sigma}$$

for $\sigma < 1$ (and vice versa for $\sigma > 1$). It follows that the capital stock k_j determined by (24) is smaller than the k_j -value that solves (23) if \hat{J} is small relative to J for $\sigma < 1$ (and vice versa for $\sigma > 1$).

Proposition 7: If productivity shocks are not perfectly correlated, an equilibrium of \mathcal{E}' is not necessarily an equilibrium of \mathcal{E}'_0 .

Contrary to Subsection 5.2, no short sales constraints are required for non-neutrality of SRI. This is in line with Heinkel et al.'s (2001, pp. 447–8) analogous result for their model with non-perfectly correlated productivity shocks.

6.4 Non-separability

The non-neutrality results in this section so far all rely on market incompleteness. Following Beltratti (2005), this subsection demonstrates the possible non-neutrality of SRI in a setting with complete financial markets and non-separable utility.

There is a complete set of state-contingent claims. Socially responsible consumers $i =$

$1, \dots, \hat{I}$ ($\hat{I} < I$) are characterized by the following non-separable utility function:

$$U_i(\mathbf{c}_i, \boldsymbol{\theta}_i, \mathbf{a}_i, \mathbf{k}) = \log c_{i0} + \beta \sum_{s=1}^S \pi_s \frac{\log c_{is}}{\frac{1}{J} \sum_{j=1}^J \exp(1 + \theta_{ij}^2)}.$$

The FM investors' utility function is

$$u_i(\mathbf{c}_i, \mathbf{k}) = \log c_{i0} + \beta \sum_{s=1}^S \pi_s \log c_{is}.$$

Firms are homogeneous and production is Cobb-Douglas with multiplicative shocks: $f_{js}(k_j) = \lambda_s k_j^\gamma$ ($0 < \gamma < 1$).

The necessary conditions for utility maximization yield $\theta_{ij} = 0$ for socially responsible consumers and

$$r_s = \frac{\beta \pi_s}{2.717 \mathbf{1}_{i \leq \hat{I}}} \frac{c_{i0}}{c_{is}}.$$

Inserting $\theta_{ij} = 0$ into U_i shows that SR investors discount date-1 utility with factor $1/2.717$ in addition to β . So condition (6) is violated. Substituting the expression for r_s into the condition for value maximization $1 = \sum_{s=1}^S r_s \lambda_s \gamma k_j^{\gamma-1}$ and eliminating the consumption levels using the market clearing conditions leads to a closed-form solution for the equilibrium capital stock:

$$k_j = \frac{\beta \gamma}{I + \frac{1.717\beta}{2.717+\beta} \hat{I}} \frac{I}{J} y_0.$$

The equilibrium capital stock in \mathcal{E} is larger than in \mathcal{E}_0 (i.e., for $\hat{I} = 0$; cf. (14)) and is an increasing function of the number of SR investors.

Proposition 8: If consumers' utility functions with social responsibility are not (separable) functions of their utility without social responsibility and their asset holdings motivated by the pursuit of SRI-related goals, an equilibrium of \mathcal{E} is not necessarily an equilibrium of \mathcal{E}_0 .

Theorem 1 and Proposition 8 jointly say that SRI is neutral unless it also has an impact on agents' consumption choices, which is a quite obvious caveat, since, of course, productive resources follow shift in demand towards certain goods.

Beltratti (2005) uses a related model in order to investigate the impact of SRI on production. He finds numerically that reduced willingness to hold a firm's stock alone has only

weak effects on stock prices and production. The impact of SRI becomes much larger if consumers also discriminate against bonds issued by the firm.

6.5 Value maximization

All versions of the model considered so far have in common that the firms' objective is to maximize the net worth generated for the initial shareholders, i.e., the difference between stock market valuation and initial shareholders' contribution to investment expenditure as of date 0. The standard justification is that this is in the unanimous financial interest of initial shareholders, as, from the budget constraints (1) and (2), any reduction in $v_{jl} - (p_0 k_{jl} - R b_{jl})$ restricts their consumption possibilities:

$$p_0(c_{i0} - y_{i0}) + \sum_{s=1}^S \sum_{l=1}^L p_{ls} c_{ils} \leq \sum_{l=1}^L \sum_{j=1}^{J_l} \bar{\theta}_{ijl} [v_{jl} - (p_0 k_{jl} - R b_{jl})].$$

Given that a subset of the consumers also have non-financial goals, it is not self-evident, however, that firms are run in a way that maximizes consumption opportunities. A possible justification for the assumption is that for each firm non-socially motivated shareholders have a majority of the voting rights initially.

There are real effects of SRI if some firms are initially controlled by socially motivated shareholders, who are willing to sacrifice consumption possibilities by choosing a capital stock that does not maximize $v_{jl} - (p_0 k_{jl} - R b_{jl})$.

An objection is that, depending on the timing of events, a takeover of such firms generates a riskless profit. To see this, let $(\mathbf{c}_i^*, \boldsymbol{\theta}_i^*, \mathbf{a}_i^*, \mathbf{z}_i^*)_{i=1}^I, \mathbf{k}^*, \mathbf{p}^*, \mathbf{v}^*, R^*$, and \mathbf{r}^* be an equilibrium of \mathcal{E} with value maximization replaced by some other criterion in some firms. Denote the capital stock that maximizes $v_{jl} - (p_0^* k_{jl} - R^* b_{jl})$, given equilibrium prices, and the resulting market capitalization as k'_{jl} and v'_{jl} , respectively. Consider the following takeover strategy targeted at an l -producer j with capital stock $k_{jl}^* \neq k'_{jl}$ and $v_{jl}^* - (p_0^* k_{jl}^* - R^* b_{jl}) < v'_{jl} - (p_0^* k'_{jl} - R^* b_{jl})$ (see Figure 3): buy all the shares of firm j at cost v_{jl}^* ; install additional capital $k'_{jl} - k_{jl}^*$; and sell the payoffs of the firm short, which generates revenue $\sum_{s=1}^S r_s^* (p_{ls}^* y'_{jls} - b_{jl})$ ($= v'_{jl}$). The date-0 cost of this strategy is less than the revenue if

$$v_{jl}^* + p_0^* (k'_{jl} - k_{jl}^*) < v'_{jl}.$$

The validity of this inequality follows from the fact that the firm does not maximize $v_{jl} - (p_0^* k_{jl} - R^* b_{jl})$. As the firm's payoff is just sufficient to unwind the short position at

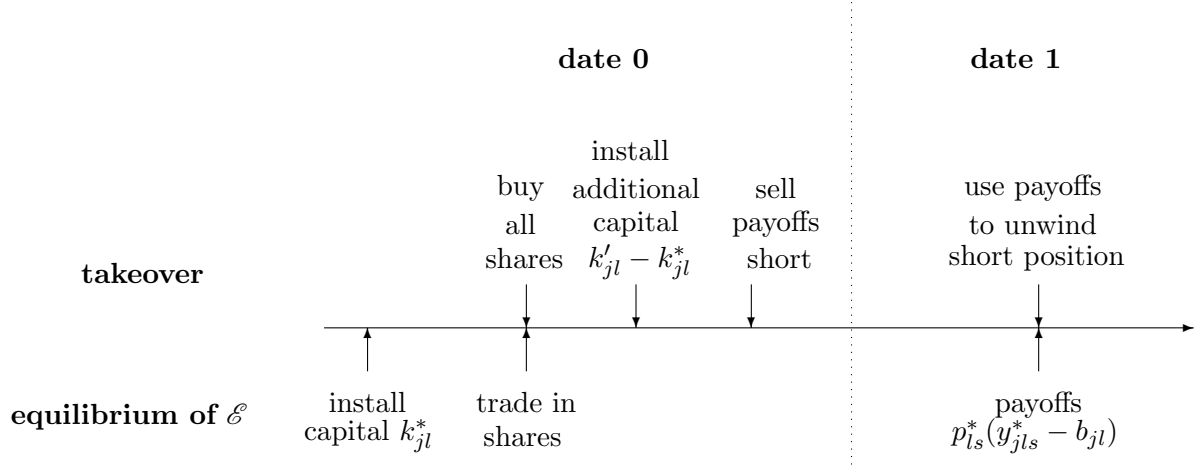


Figure 3: Takeover

date 1, the takeover strategy generates a riskless profit.⁷

7 Conclusion

With complete financial markets SRI is neutral unless it also has an impact on agents' consumption choices. Irrespective of completeness of the financial market, SRI is also neutral if all firms are identical and experience identical productivity shocks.

Market completeness is a weak condition in theory. As pointed out by Ross (1976), it suffices that there exists a portfolio with different payoffs in each state and that it is possible to write options on that portfolio.

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⁷Obviously, the takeover strategy is vulnerable to the Grossman-Hart (1980) criticism: shareholders have an incentive to free-ride on the raider's effort to increase firm value.

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